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ABSTRACT

A discussion of the use of generative phonology in the speech clinic, especially with children, begins with an outline of some constructs of generative phonology. First, some notes on phonetic notation and definitions of terms used in nongenerative phonology that have special meanings in this field are presented. Then a discussion of distinctive features defines and distinguishes major class features, tongue body features, place of articulation features, manner of articulation features, and prosodic features and redundancy. The principles and writing of phonological rules in generative phonology are described, including rule conventions, phonological processes and rules, rule ordering, and rule collapse. Another section discusses the problem of relating abstraction to underlying forms as it occurs in clinical applications. Finally, a case study is used to illustrate the steps in applying generative phonology to the evaluation of a child's language. The steps include data collection, establishing the phonetic inventory and inventory of segments tested, making informal observations, writing formal rule statements, and making recommendations for therapy. (MSE)

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Generative phonology in the clinic

Jeffrey L. Kallen

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(continued on back cover)

Autumn 1984

GENERATIVE PHONOLOGY IN THE CLINIC

by

JEFFREY L. KALLEN

0 INTRODUCTION

Generative phonology has provided the major impetus for the development of phonological theory over the last fifteen years. Combining the concept of functional oppositions in sound systems developed in the Prague School of linguistics in the 1920s and 1930s with later developments in structural phonemics and instrumental phonetics, generative phonologists have developed descriptive practice and explanatory theory to account for the ways in which speakers use sound systems to relate sound to meaning. The theoretical axiom that phonological utterances are produced according to rules which generate phonetic segments from abstract underlying representations gives rise to the term "generative" phonology. In harmony with other generative principles of linguistic theory, generative phonology ultimately attempts to relate patterns of phonetic behaviour to the organization of the human mind. To accomplish this task, generative theory relies on the development of abstract descriptive and explanatory devices, since primary language data alone do not make clear the principles which account for or explain linguistic behaviour.

This paper is addressed to the application of generative phonology in clinical practice, especially that related to children. Some constructs presented here, such as distinctive feature theory, are common to many non-generative approaches to phonology. No attempt is made to survey the generative school for alternatives to the rules and analyses I have proposed. For arguments within and about generative phonology, see the references at the end of this paper. Because patients' behaviour is individual and not always consistent even within the individual case, the following clinical examples are by no means exhaustive. Rather, I attempt here to illustrate a general method for organizing and interpreting data in the clinical context.

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1 SOME PRELIMINARIES

1.1 Phonetic notation

Phonetic symbols are used here in accord with conventions in generative phonology. Though most of these conventions agree with I.P.A. notation, some points of contrast (which are largely motivated by ease of printing and assume no theoretical significance) are noted below:

<u>I.P.A.</u> (as commonly used)	<u>Alternative</u>	<u>Sound</u>
ʃ	š	voiceless palatal fricative
ʒ	ž	voiced palatal fricative
j	y	palatal glide
y	u	front high round vowel
tʃ	č	voiceless palatal affricate
dʒ	ǰ	voiced palatal affricate
o	u	high back vowel

1.2 Some terms

Many terms which are familiar in non-generative approaches to phonetics and phonology are used in generative phonology with special meanings. Following is a list of some of these.

<u>Phonetics</u>	The level of linguistic organization pertaining to the actual production of sounds.
<u>Phonology</u>	The level of linguistic organization pertaining to the representation of sounds in a system, either mentally or in the abstract (depending on one's theoretical point of view), but not at the level of production.
<u>Phoneme</u>	An underlying unit of phonological representation, never uttered, which, following the operation of phonological and realization rules, is realized in a specific phonetic form.
<u>Rule</u>	A process (or linguistic description of a process) whereby forms of linguistic organ-

ization are transformed into other forms by explicitly defined changes. Phonological rules change the "deepest" underlying representation (UR) into a final abstract (i.e. not uttered) representation, while realization rules change this representation to the actual phonetic form uttered by the speaker. Though not all generative theorists would agree, I have used the term surface representation (SR) in this paper to refer to actual phonetic production. Thus abstract phonological representations are enclosed in slanted lines (/ /), while utterances are enclosed in square brackets ([]).

2 DISTINCTIVE FEATURES

Phonologists use distinctive features to classify functional units of sound into groups according to explicit phonetic criteria. Using distinctive features, phonemes are not seen as indivisible entities, as is implied by phonetic transcription, but as "bundles of features" co-occurring uniquely for each phoneme in the language. Breaking phonemes down into constituent features facilitates linguistic analysis by providing a more precise phonetic description of sounds than is possible in more impressionistic schemes, and by enabling the analyst to formulate phonological rules that capture significant linguistic generalizations.

Distinctive features are defined independently of any particular language. Formulating a universal set of features, a subset of which is relevant to any given language, helps to elucidate universals in phonology and to clarify the relations within and across languages.

The most comprehensive single work in generative phonology which develops and uses distinctive features is Chomsky and Halle's The Sound Pattern of English (1968), known to phonologists as SPE. The following discussion is based primarily on SPE and later interpretations of SPE by other writers.

Distinctive features fall into four major classes, which can be organized into a rough hierarchy as discussed below. For each sound, a given constituent feature has a binary value (plus or minus) at the phonological level, while real number values (e.g. from 0 to 1.0 or 1 to 5) are assigned by realization rules to show the relative strength of different features at the phonetic level. Phonologists are usually concerned with changes at the phonological level, and only rarely with attaching specific phonetic value to the features describing phonemes. In SPE and some later treatments, distinctive features are defined in terms of words and antonyms, e.g. sonorant vs. non-sonorant or voiced vs. voiceless. When binary values are consistently applied,

however, the antonymous forms are redundant, and it is more convenient to describe sounds as plus or minus [voice], plus or minus [nasal], etc.

The major classes of distinctive features discussed in this paper are as follows. Major class features specify sounds on articulatory criteria into categories of obstruents (stops, known also as plosives, fricatives, and affricates); vowels; liquids (/l/, /r/ and related sounds); glides (/w/, /y/ and related sounds); and, with the feature [nasal], nasals. The major class features separate sounds into categories which are then subdivided. Tongue body features define both vowels and consonants according to the movement of the body of the tongue from a "neutral" position, roughly corresponding to that of /ε/. Place of articulation features classify sounds on the basis of articulation along an anterior-posterior axis within the oral cavity. Manner of articulation features pertain to the movements of the airstream mechanism and movements of the lips and vocal cords.

2.1 Major class features

2.1.1 Sonorant

Sounds which are [+sonorant] are produced with the vocal tract open so that no significant impedance (friction or stoppage of the airstream mechanism) occurs during production. Chomsky and Halle (SPE, pp. 301f.) define sonorants as sounds which are produced in a way that makes "spontaneous voicing" possible. "Spontaneous voicing" denotes the vibration of the vocal cords which occurs when (i) the cords are close enough together to allow voicing (unlike the situation found in normal breathing) and (ii) there is a lack of constriction in the oral cavity such that the airflow may continue relatively unimpeded. Voicing occurs spontaneously due to the alternations in different degrees of pressure above and below the glottis. Chomsky and Halle differentiate this type of voicing from that which occurs where oral closure is present, as in voiced stops such as /b/ and /d/. Sounds which are [-sonorant] include stops, affricates, and fricatives, as well as strident liquids (Czech ř) and liquids in some languages which involve a high degree of constriction in the vocal tract. Sounds which are [+sonorant] include vowels, liquids, nasals, and glides.

2.1.2 Syllabic

Chomsky and Halle (SPE, p. 354) propose the feature [syllabic] as an alternative to the earlier-

discussed feature [vocalic] (SPE, p. 302). The feature [syllabic] is defined in terms of the function of a segment in a syllable - it "would characterize all segments constituting a syllabic peak" (SPE, p. 354). Obstruents (which are [-sonorant]) are automatically [-syllabic], while all vowels are automatically [+syllabic]. Glides are [-syllabic], while nasals and liquids are normally [-syllabic]. They may, however, become [+syllabic] when they constitute the syllable peak, as in /bat/, "bottle", where no vowel intervenes between /t/ and /l/. Vowels often become glides ([-syllabic]) in certain environments, while glides may occupy syllable peaks and become [+syllabic]. High front vowels usually interchange with /y/ and high back vowels with /w/ in such environments.

2.1.3 Consonantal

Sounds which are [+consonantal] require a significant obstruction in the vocal tract. Vowels are always [-consonantal]. Glides, although not occupying syllable peaks, and hence [-syllabic], are also [-consonantal] because the degree of constriction between the tongue and the palate in articulating these sounds does not cause friction or stoppage of the airflow. Liquids and nasal consonants, on the other hand, while maintaining spontaneous voicing, require the tongue or other primary articulators to obstruct the airflow and are thus [+consonantal] sonorants. Obstruents always require friction or stoppage of the airflow, and are therefore [+consonantal].

2.1.4 Summary

The major class features may be summarized as follows:

<u>Sound class</u>	<u>Sonorant</u>	<u>Syllabic</u>	<u>Consonantal</u>
Vowels	+	+	-
Liquids	+	-	+
Nasals	+	-	+
Glides	+	-	-
Obstruents	-	-	+

2.2 Tongue body features

All tongue body features are defined in terms of movement of the body (not the tip or corona) of the tongue from the "neutral position" of the tongue in articulating the sound /ɛ/. These features classify both consonants and vowels according to the same criteria.

2.2.1 High

Sounds which are [+high] require movement of the tongue above neutral position. The sounds /k/ and /t/ are both [+high], while /ɛ/ (in which only the corona of the tongue is raised) and /a/ are both [-high].

2.2.2 Low

Sounds which are [+low] require articulation below the position of the body of the tongue in neutral position. Low vowels such as /a/ and the consonants /h, ʔ/ and related sounds are [+low]. Mid vowels and most other consonants are [-high] and [-low]. Binary feature classifications make a concept such as [mid] unnecessary.

2.2.3 Back

In [+back] sounds the tongue is retracted from neutral position. Sounds such as /k, g, ŋ, a, u/ are all [+back], while /ɕ, p, i, e/ are [-back]. Central vowels are [+back], as they are retracted relative to /ɛ/.

2.2.4 Summary

Table I lists some common phonemes:

TABLE I

<u>Feature</u>	p	ɕ	q	m	ŋ	l	y	i	a	u	o	h
Sonorant	-	-	-	+	+	+	+	+	+	+	+	-
Syllabic	-	-	-	-	-	-	-	+	+	+	+	-
Consonantal	+	+	+	+	+	+	-	-	-	-	-	+
High	-	+	+	-	+	-	+	+	-	+	-	-
Low	-	-	-	-	-	-	-	-	+	-	-	+
Back	-	-	+	-	+	-	-	-	+	+	+	-

Note that it is possible to group phonemes together on the basis of shared features. The class sharing the feature [-consonantal] includes /y, i, a, u/, the class [+high] includes /ɛ, ɐ, ʊ, y, i, u/, and so forth. The division of a sound system into classes helps to illustrate important phonological regularities, and is quite useful in clinical phonology, where many phonemes may undergo the same process.

2.3 Place of articulation features

2.3.1 Anterior

An obstruction of the airflow great enough to cause friction or stoppage occurs slightly in front of the palato-alveolar ridge (where /ʃ/ is normally pronounced) in [+anterior] sounds. Vowels and glides are [-anterior] since they do not involve obstructions. Bilabial and purely alveolar consonants are [+anterior], while velars are [-anterior].

2.3.2 Coronal

Sounds which are [+coronal] are articulated with the blade of the tongue raised from neutral position. Most vowels and glides are [-coronal], although some languages have retroflex vowels, classed as [+coronal]. In articulating coronal sounds, the blade or tip of the tongue usually touches or comes close to the palate or teeth.

2.3.3 Grave

[Grave] is not used in SPE, and Chomsky and Halle (p.306) suggest that the concept it denotes is adequately accounted for by the features [back] and [coronal]. This feature can be defined acoustically, noting that consonants formed at the periphery of the oral cavity (bilabials, velars, and glottal sounds) share with back vowels and /w/ a concentration of energy in the lower frequency end of the sound spectrum. Such sounds are [+grave]. Non-back vowels, as well as consonants which are dental, alveolar, or palatal, divide the oral cavity into two small cavities (unlike the [+grave] segments): this division concentrates energy in the higher frequency end of the spectrum. Such sounds are accordingly [-grave].

Although the above definition is acoustic, the

same facts can be captured in articulatory terms: [+grave] segments are articulated either forward of the area where coronals are produced (i.e. as bilabials) or behind the palatal area. While features such as [back] and [coronal] adequately classify phonemes, Hyman (1975, p.31) shows with an example from Fefel-Bamileke that phonological processes may better be accounted for by using the feature [grave] than by relying on a more complex combination of features to capture the relevant generalizations. The phonological processes known to clinicians as "backing" and "fronting" are often accounted for in phonological rules using the feature [grave].

2.3.4 Summary

Table II lists some common segments:

TABLE II

Feature	p	f	θ	t	z	ʃ	ç	c	ç	g	m	ŋ	w	r	h
High	-	-	-	-	-	+	+	+	+	+	-	+	+	-	-
Back	-	-	-	-	-	-	-	-	-	+	-	+	+	+	-
Anterior	+	+	+	+	+	-	-	-	-	-	+	-	-	+	-
Coronal	-	-	+	+	+	+	+	-	-	-	-	-	-	+	-
Grave	+	+	-	-	-	-	-	-	-	+	+	+	+	-	+

Note the implicational relations in this table. All [+coronal] segments are [-grave]; all [+back] are [+grave]. All [+anterior] are [-back], but not all [-anterior] are [+back]: the palatals and palato-alveolars are [-anterior, -back], as is /h/.

2.4 Manner of articulation features

2.4.1 Round

Not always seen as a manner feature, [round] labels sounds relative to what Chomsky and Halle (SPE, p.309) term "a narrowing of the lip orifice". In traditional terms, rounding contrasts with the "spread" lip position. Vowels such as /u, ə, o/ and consonants such as /bʷ, w, kʷ/ are [+round].

2.4.2 Interrupted

Sounds which are [+interrupted] require complete closure in the oral cavity at some point in the articulation. Stops are all [+interrupted], while vowels and glides are [-interrupted]. Nasal consonants and glottal stop are also [+interrupted] since they depend on closure of the airstream in the oral cavity. Likewise, affricates are [+interrupted], as they require stoppage prior to the release of a fricative. Liquids present a special problem, discussed in SPE (p.318). In some cases they may follow phonological rules applying to stops, while in other cases they seem to behave as if they were [-interrupted]. Liquids are usually classed as [-interrupted] by most phonologists today. Vowels and fricatives are [-interrupted].

The feature [interrupted] stands in inverse relation to the feature [continuant], which is used by some authors. Since all segments which are [+interrupted] are [-continuant] and vice versa, there is no need for both features in a single feature list.

2.4.3 Delayed release

This feature is used to distinguish affricates from their related stops. It is predicated on prior closure in the vocal tract - if release from the closure is delayed, turbulence results and a fricative sound results. Affricates such as /p^h, t^h, k^h/ are [+delayed release], while stops are all [-delayed release]. This feature does not apply to sounds which are [-interrupted].

2.4.4 Strident

Strident sounds are produced with a relatively greater degree of turbulence (heard as noise) as the airstream passes over the area of articulation. Sonorants and stops (excluding affricates) are all [-strident]. Affricates such as /t^h, k^h/ and fricatives such as /s, z, ʃ, ʒ/ are [+strident], while /p, b, m/ are [-strident]. The feature [strident] does not usually define minimal pairs in English, though it does in languages such as Czech, where the strident /ř/ of rada "row" contrasts with that of rada "council". Because of its acoustic element, [strident] is often useful in describing clinical phonological patterns where various strident fricatives are collapsed into a single phoneme. Many realizations of the Hiberno-English lenited ("soft" or "whistling") /t/, found in some productions of "but" or "cat" (written [x] in phonetic notation) are strident alternants of the non-

strident [t].

2.4.5 Nasal

[+nasal] denotes sounds produced with the velum lowered to allow air to pass through the nasal cavity. In [-nasal] sounds, the velum is high enough to block nasal airflow. The degree of nasal airflow varies with the degree of velar closure: nasal or nasalized vowels involve both oral and nasal resonance, since vowels by definition cannot have obstruction of the oral cavity. Cleft palate or other conditions found in clinics may prevent absolute closure or full opening at the velum such as is suggested by binary classification at the phonemic level. Nasalization may occur either underlyingly (as with nasal consonants or a nasal vowel such as French /õ/) or as the result of nasal assimilation, in which a non-nasal segment takes on the feature [+nasal] from a surrounding segment.

2.4.6 Lateral

A sound which is articulated with the airstream flowing around the sides of the tongue is [+lateral]. This feature is most often found in /l/, although fricatives such as /ɬ/ and the Chippewa affricates /tɬ, dɬ, tɬ'/ (found in other languages as well) are also [+lateral]. In normal adult English [lateral] is used only to distinguish between /l/ and /r/, which are both coronal anterior sonorants but differ in laterality. The voiceless lateral fricative /ɬ/ is common in Welsh and other languages and frequently appears, along with its voiced counterpart [ɮ], in clinical phonology in English.

2.4.7 Voice

This feature parallels the traditional articulatory concept. Although Chomsky and Halle (SPE, pp.327f.) present a more detailed discussion of considerations such as voicing onset (the time at which voicing begins during the articulation of a segment), it is usually sufficient to define as [+voiced] those segments whose articulation includes the vibration of the vocal cords. All sonorants except voiceless vowels are by definition [+voiced], while obstruents may be [+voiced] as in /b, d, g/ or [-voiced] as in /p, t, k/. Though some languages, e.g. Japanese, have vowels which are voiceless in all environments, many languages including English devoice vowels in certain environments.

2.4.8 Tense

Sounds which are [+tense] are produced with relatively high tension or muscular effort in the region above the glottis, particularly in the lips and tongue. Distinctions of [+tense] are generally used to classify vowels and usually imply further phonetic characteristics. The exercise of tension in articulation involves muscular activity which tends to make [+tense] segments longer and higher than their lax, i.e. [-tense], counterparts. Although the feature [tense] is rarely used to classify consonants, voiced consonants are generally [-tense], while voiceless consonants are [+tense]. In English, /i, e, u, o, a/ are [+tense], and /ɪ, ɛ, ʊ, ɔ, ʌ/ are [-tense]. The difference in length between, for example, /i/ and /ɪ/ in most varieties of English is defined in distinctive features by a difference in the value for [tense] rather than a feature [long].

2.4.9 Summary

Table III lists some common segments.

TABLE III

Feature	p	t	f	v	ʃ	ʒ	w	l	r	n	θ	ð	o	ɔ	ɜ
Round	-	-	-	-	-	-	+	-	-	-	-	-	+	+	+
Interrupted	+	-	-	-	+	-	-	-	-	+	-	-	-	-	-
Delayed release	-				+					-					
Strident	-	-	+	+	+	+	-	-	-	-	-	-	-	-	-
Nasal	-	-	-	-	-	-	-	-	-	+	-	-	-	-	+
Lateral	-	-	-	-	-	-	-	+	-	-	-	-	-	-	-
Voice	-	-	-	+	+	+	+	+	+	+	-	+	+	+	+
Tense	+	+	+	-	-	-	-	-	-	-	+	-	+	-	-

Note the distinctions between sounds which are made on the basis of a single feature: /l/ and /r/ are identical except for the feature [lateral], /o/ and /ɔ/ differ only on the feature [tense], /t/ and /f/ only on the feature [strident], etc.

2.5 Prosodic features

In addition to the articulatory features discussed above, there is a small group of features defined according to traditional prosodic concepts.

2.5.1 Stress

The feature [+stress] denotes a segment carrying stress within a word. Stress is not usually an underlying property of segments, but is assigned within a word or phrase according to stress assignment rules. Different languages have different rules for assigning stress: word stress in Hungarian always falls on the vowel in the first syllable, while in Polish it falls on the penultimate syllable. Stress in Irish very often falls on the first syllable, unless the word contains a long vowel, in which case it falls on the first long vowel. The stress pattern of English is quite complicated: much of SPE is devoted to working out English stress patterns.

2.5.2 Length

The feature [long] refers to length used distinctively to differentiate between phonemes, or to a quality assigned by rule: it would not generally be used where length is predictable on purely phonetic grounds. Thus the tense vowels in English are not described as [+long], though in contrast it may be desirable to write a rule for English which recognizes the typical lengthening of vowels before voiced segments (e.g. the /i/ of /pɪg/ "pig" is longer than the /i/ of /pɪk/ "pick"). In languages such as Hungarian, vowels and consonants may be distinctively [+long] rather than environmentally conditioned for length, resulting in minimal pairs such as /mɛg/ "and" vs. /mɛ:ɡ/ "still".

2.6 Redundancy

A matrix such as any of the preceding tables shows distinctive feature values for some set of sound segments. Many of these values, however, are redundant in that they only add information which is predictable on the basis of other feature values. Thus it is predictable, for example, that a segment which is [+nasal] is [+voiced], that one which is [+strident] is underlyingly [-nasal], etc. Implicational rules state relationships of redundancy, deduced on either a universal basis (such as the implications above) or on a language-specific basis from a

given feature matrix.

Table IV gives a complete feature matrix for the major distinctive features and an associated set of segments. The abbreviations for the distinctive features below will be used in the rest of this paper.

TABLE IV

Feature	p	b	d	č	ž	k	g	h	y	r	ŋ	a	i	o
Cons	+	+	+	+	+	+	+	+	-	+	+	-	-	-
Son	-	-	-	-	-	-	-	-	+	+	+	+	+	+
Syll	-	-	-	-	-	-	-	-	-	-	-	+	+	+
Hi	-	-	-	+	+	+	+	-	+	-	+	-	+	-
Lo	-	-	-	-	-	-	-	+	-	-	-	+	-	-
Back	-	-	-	-	-	+	+	-	-	-	+	+	-	+
Ant	+	+	+	-	-	-	-	-	-	+	-	-	-	-
Cor	-	-	+	+	+	-	-	-	-	+	-	-	-	-
Grave	+	+	-	-	-	+	+	+	-	-	+	+	-	+
Rnd	-	-	-	-	-	-	-	-	-	-	-	-	-	+
Int	+	+	+	+	-	+	+	-	-	-	+	-	-	-
Del rel	-	-	-	+		-	-				-			
Stri	-	-	-	+	+	-	-	-	-	-	-	-	-	-
Nas	-	-	-	-	-	-	-	-	-	-	+	-	-	-
Lat	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Vcd	-	+	+	-	+	-	+	-	+	+	+	+	+	+
Tense	+	-	-	+	-	+	-	-	+	-	-	-	+	+

Table IV is massively redundant: it contains far more information than is needed to specify each segment uniquely. The features [grave], [lat], and [tense], for example, are entirely redundant: they are not necessary to distinguish any one segment from others. Since all segments are [-lat], it adds no distinctive information to specify this fact about any segment. Although not all segments are [-stri], it is unnecessary to specify the value [+stri] in a minimal

distinctive feature specification for /č/ or /ž/, because these two segments can be more economically denoted using only the features [del rel] or [hi], [cor], and [int].

In Table V all redundant information is eliminated and each phoneme is specified uniquely by the minimal set of features which contrast it with all others.

TABLE V

Feature	p	b	d	č	ž	k	g	h	y	r	ŋ	a	i	o
Cons								+	-					
Son			-			-			+					
Syll									-			+	+	
Hi					+								+	
Lo								+				+		
Back						+	+							
Ant	+	+	+											
Cor	-	-	+		+					+				
Int					-									
Del rel				+										
Nas											+			
Rnd														+
Vcd	-	+				-	+							

Table V shows, for example, that the minimal specification for /r/ is [+son, +cor], as there is no other segment in the inventory which meets this description. Any further specification is thus redundant. The segment /o/ is uniquely specified as [+rnd], since it is the only such segment in the set. The more similar two segments are, the more features are generally needed to specify each uniquely: the feature [voiced] here would be entirely redundant were it not for the otherwise identical pairs /p,b/ and /k,g/.

The choice of which features to use in a minimal specification where more than one equally economical description is possible varies somewhat among phonologists, but it is generally governed by considerations such as the hierarchy of features (the order presented in the matrix), clarity of

explanation (major class features or those which correspond to well-known articulatory categories are best understood by most readers), and so forth. In-depth phonological analysis is excessively cumbersome and loses important linguistic generalizations without the elimination of redundant descriptions.

3 PHONOLOGICAL RULES

The value of phonological rules in expressing linguistic generalizations or patterns is shown below. Consider the Latin data in Table VI, taken from Schane and Bendixen (1978, p.77).

TABLE VI

<u>Gloss</u>	<u>Nominative</u>	<u>Genitive</u>
1. fortress	arks	arkis
2. leader	duks	dukis
3. feast	daps	dapis
4. snake	se:ps	se:pis
5. king	re:ks	re:gis
6. phalanx	falanks	falangis
7. city	urps	urbis
8. people	pleps	plebis

Both columns of Latin data in Table VI contain a base morpheme, plus a suffix: -s for the nominative case and -is for the genitive. Phonological analysis must account for the alternation between final voiced and voiceless consonants in the base morpheme of each word. Note that all the nominative bases end in voiceless consonants, while genitive forms may end in either voiced or voiceless segments.

The most economical way to account for this alternation is to assume that the base has an underlying form which is invariant (the same for nominative and genitive), but which is altered by a phonological rule that is sensitive to the environment in which the segment to be altered is found. Intuitively, the rule here appears to convert voiced segments (/g,b/) into voiceless ones when they are immediately followed by the voiceless segment /s/. This process would be one of voicing assimilation, in which a

given segment (in this instance a voiced one) takes on the feature value of a nearby segment (a voiceless one in this example). A single rule, given below, must account for all the cases in which this devoicing is found.

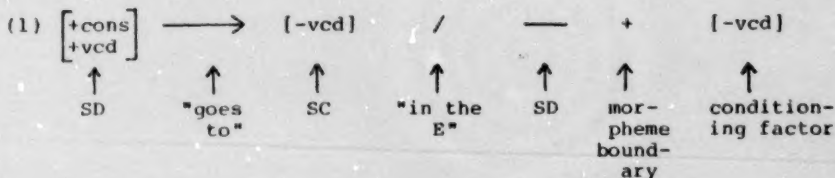
3.1 Writing phonological rules

Phonological rules are formalized as follows. The structural description (SD) of a rule names the features or segments (that is, the structures) which undergo the change which the rule denotes. The SD is written as economically as possible, using only the information necessary to specify the structures undergoing the change.

The structural change (SC) of the phonological rule follows an arrow in the rule formalization (read as "goes to" or "becomes") and states which new feature or configuration of features is created by the rule. This statement is also as economical as possible, with only those features that change listed. Features which remain unchanged are left out of the SC.

A diagonal line following the SC is read as "in the environment" and is followed by a statement of the environment (E) in which the change occurs. This statement, too, is as economical as possible: just enough information is given to specify all and only the environments in which the change occurs. A dash (—) in the E statement indicates the location of the structure undergoing change, while the other information notes the factors which condition the change.

The rule which accounts for the data in Table VI is as follows:



Note the following features of rule (1):

- (i) The suffixes are present in the underlying form of the word: they are inserted via word formation rules prior to the operation of phonological rules.
- (ii) The change occurring to /b/ and /g/ is collapsed into a single rule.

- (iii) A prediction is made that the devoicing rule will apply to other voiced consonants. The feature [+cons] is strictly speaking redundant, since it is not necessary to state this condition on the basis of the data given: other data, however, show that the rule only applies to obstruents.
- (iv) Although the rule includes a morpheme boundary in the E component, it makes no reference to the case of the noun. The rule applies only to phonology, with the appropriate morphemes (and their boundaries) acting only as phonological conditioning factors.

3.1.1. Rule conventions

The rule conventions adopted by generative phonologists make it possible for a great deal of phonological information to be condensed into simple rules. In addition to those mentioned above, note the following:

TABLE VII

- # — word boundary (end or beginning of a word)
- ‡ — Syllable boundary (division between two syllables in a word)

In combination with the dash (—) denoting the position of a segment undergoing a change in a phonological rule, the environment of a segment can thus be described:

- #— equals "word-initial"
- V—V equals "between two vowels"
- C—V equals "following a consonant and before a vowel"
- # equals "word final"
- + V equals "before a morpheme beginning with a vowel"
- ‡ equals "at the end of a syllable"
- ‡— equals "at the beginning of a syllable"

Additionally, curly brackets ({}) and angle brackets (<>) extend the power of phonological rules. Curly brackets are read to mean "choose one", while

angle brackets take an "if ... then" interpretation. Thus note the following two rules:

$$(2) \quad [+cons] \longrightarrow [-vcd] \quad / \quad \text{---} \left(\begin{array}{c} \# \\ + \end{array} \right)$$

$$(3) \quad \left[\begin{array}{c} +cons \\ +vcd \\ <+hi> \end{array} \right] \longrightarrow \left[\begin{array}{c} -vcd \\ <-int> \end{array} \right] \quad / \quad \text{---} \quad [-vcd]$$

Rule (2) may be read as "a consonant becomes [-vcd] before either a word boundary or a morpheme boundary". Rule (3) may be read as follows: "a voiced consonant becomes [-vcd] before a voiceless segment: if the voiced segment is also [+hi], then the segment also becomes [-int]". Features which are common to all members of a class are not in angle brackets, while those features specific to a subset of the class are placed in angle brackets.

3.2 Phonological processes and phonological rules

Table VI illustrates a common process (assimilation) in both normal and clinical phonology. Many other processes are common which do not involve the assimilation of one segment to another.

Perhaps the best-known example of non-assimilatory rules in generative phonology is that of German final obstruent devoicing. Words in German display phonological alternations between voiced and voiceless final consonants, as shown in Table VIII.

The alternation in Table VIII is that between voiceless consonants word-finally and their voiced counterparts between vowels, found in words 1, 2, and 4-7. Words 3 and 8-10 show that it is permissible to have voiceless segments intervocally: hence a voicing assimilation rule is not applicable. Since phonological theory requires the formulation of an invariant underlying base morpheme for these words, the only logical possibility is to state that the words which show an alternation have underlyingly voiced final consonants, while the others have underlyingly voiceless final consonants. The underlying voiced consonants are then devoiced in word-final position: a following morpheme blocks the application of the rule. This pattern is shown in rule (4).

TABLE VIII

<u>Surface representa- tion (SR)</u>	<u>Gloss</u>	<u>Surface representa- tion (SR)</u>	<u>Gloss</u>
1. zik	victory	ziga	victories
2. rat	wheel	rades	of the wheel
3. rat	advice	rates	of the advice
4. gras	grass	grazes	of the grass
5. dip	thief	diba	thieves
6. giba	big (pred.)	grosa	big (attrib.)
7. tak	day	taga	days
8. hut	hat	huta	hats
9. lak	varnish	lake	varnishes
10. krep	crepe	krepa	crepes

$$(4) \quad \begin{bmatrix} +\text{cons} \\ -\text{son} \end{bmatrix} \longrightarrow [-\text{vcd}] / \text{---} \#$$

Other common phonological processes include:

apocope - loss of a final segment in a word;

syncope - loss of a segment elsewhere;

prothesis - addition of a segment initially;

epenthesis - addition of a segment elsewhere;

metathesis - transposition of segments.

These processes, which can only be defined and described by analysis based in phonological theory, are common both in normal phonology of natural languages and in problems which arise in clinics. Clinical phonology is in principle amenable to the same kinds of phonological analysis as "normal" phonology, although the nature of the rules and rule theories required will differ as a function of the irregularity and developmental contingency of clinical data.

3.3 Rule ordering

Rules (1) and (4) account for data in which only one phonological rule applies. Often, however, several rules ordered with respect to each other are needed to account fully for the alternations in the corpus.

To illustrate the importance of rule ordering, consider German again. The examples in Table VIII are simplified in order to illustrate consonant devoicing more clearly. In addition to the devoicing process, German shows a lengthening of short vowels before voiced obstruents, with the exception of a few words. King (1969, p.52) suggests rule (5) to account for this lengthening:

$$(5) \quad [V] \rightarrow [+long] / \text{---} \left[\begin{array}{l} -son \\ \downarrow \\ vcd \end{array} \right]$$

That is, a vowel becomes long before a voiced obstruent.

King's presentation of the history of German shows that many dialects which contain both rules (4) and (5) have undergone a change in the order of application of the rules, with a consequent change in the surface realizations of the underlying forms. According to King (1969, pp.52f.), devoicing was added to German around A.D. 1000, while vowel lengthening did not come in until around A.D. 1700. At some point in the 15th and 16th centuries the derivations set out in Table IX would have applied.

TABLE IX

UR	/lob/	/lobes/	/veg/	/vege/	/graz/	/grazes/
Rule (4)	/lop/	-----	/vek/	-----	/gras/	-----
Rule (5)	----	/lo:bas/	----	/ve:ge/	-----	/graz:zes/
SR	[lop]	[lo:bas]	[vek]	[ve:ge]	[gras]	[graz:zes]
Gloss	praise	of the praise	path	of the path	grass	of the grass

ret the surface forms of Table IX are not found in contemporary German. King (ibid.) shows that a reversal of the above order, which must have occurred historically, yields the correct surface forms for the contemporary language:

TABLE X

UR	/lob/	/lobes/	/veg/	/vege/	/graz/	/grazea/
Rule (5)	/lo:h/	/lo:bos/	/ve:g/	/ve:ges/	/graz:/	/grazes/
Rule (4)	/lo:p/	-----	/ve:k/	-----	/gra:s/	-----
SR	[lo:p]	[lo:bos]	[ve:k]	[ve:ge]	[gra:s]	[grazes]

Tables IX and X illustrate the importance of rule ordering. In both stages of German, the same underlying forms are used and the same rules are used - switching the order of application of the rules yields two different sets of surface results. In the modern case, forms such as [lo:p] and [ve:k] seem to be a contradiction of rule (3): lengthened vowels are found, but not in the environment specified by the rule. Such a contradiction does not arise in Table IX. These contradictions fall out as a result of the ordered application of phonological rules and must be accounted for within generative theory.

Generative phonologists have proposed a number of principles to account for rule orderings. The ordering in Table IX illustrates one of minimal opacity, i.e. the degree to which surface forms contradict forms dictated by phonological rules. All the surface forms of Table IX are in keeping with both the phonological rules in the derivation - hence the derivation is transparent. The ordering of Table X is more opaque than that of Table IX as there are surface forms in it which contradict rule (5). Yet the ordering in Table X is one of maximum application - rule (5) applies more often than it did in Table IX. The history of German illustrates the possibility that maximum application is preferred in rule orderings to maximum transparency - hence the change over time. There is a clear analogy with child language and clinical phonology as well: the development of normal adult phonology may require a change in the rule ordering used by a speaker, rather than any change in underlying forms, forms of rules used, etc. Rule ordering principles have been the subject of much debate in generative phonology - for further reference, see Kenstowicz and Kisseberth (1977).

3.4 Rule collapse using the alpha convention

The structural descriptions of rules (1), (4) and (5) accounted for several different phonemes undergoing an identical feature-changing process. In some cases, particularly in assimilation or dissimilation, several phonemes undergo a common process which cannot be described using a single binary feature value, but which requires a statement to the effect that "X agrees with Y in a value for Z". Consider

the data from Yoruba, a language of North Africa, set out in Table XI (the data are taken from Schane and Bendixen 1978, p.49):

TABLE XI

<u>Gloss</u>	<u>Stem</u>	<u>Present progressive</u>
1. stop	kuro	gkuro
2. buy a dress	rass	nrass
3. say	wi	gwi
4. go	le	nle
5. spoil	baje	mbaje
6. to be sad	fibanuje	mfibanuje
7. press sand	tryerin	ntryerin

In Table XI there is an alternation among three different forms of the present progressive morpheme: [ɔ,n,m]. The underlying form of this morpheme is clearly [+nas, +cons], since all three surface forms share these two features, but the surface representation of the morpheme depends on the features of the following consonant, i.e. the first consonant of the base morpheme. In particular, the form of the present progressive agrees in value with the following consonant for the features [back] and [coronal], as shown in Table XII:

TABLE XII

<u>+back</u> <u>+coronal</u>	<u>+back</u> <u>-coronal</u>	<u>-back</u> <u>+coronal</u>	<u>-back</u> <u>-coronal</u>
(impossible)	gkuro gwi	nrass nle ntryerin	mbaje mfibanuje

Rule (6) accounts for the data in a special way. Rather than using binary values in the formalization of the rule, Greek letters (α, β, γ, etc.) stand in the place of pluses and minuses, to be read as "plus or minus" a feature X. Rule (6) thus denotes the four logical possibilities of Table XII, by allowing the segment in the SC to become [±back] and [±coronal], on the condition that the features

of the changed segment agree with the feature values found in the environment. Thus a segment which is [+nasal] may become [+back, -coronal] if the following consonant is [+back, -coronal], etc.

$$(6) \quad [+nasal] \longrightarrow \begin{bmatrix} \alpha \text{ back} \\ \beta \text{ cor} \end{bmatrix} \quad / \quad \text{---} + \begin{bmatrix} \alpha \text{ back} \\ \beta \text{ cor} \end{bmatrix}$$

That is, a nasal segment must have the same value for [back] and the same value for [coronal] as the consonant which follows it on the other side of a morpheme boundary.

The alpha convention can be used for dissimilation as well, simply by putting a minus sign before the appropriate Greek letter. Thus a hypothetical rule (7) would require voicing dissimilation between a consonant and a following segment:

$$(7) \quad [+cons] \longrightarrow [-\alpha \text{ vcd}] \quad / \quad \text{---} [\alpha \text{ vcd}]$$

That is, a consonant must have the opposite value for [voiced] to the segment which follows it.

4 A PROBLEM AREA: ABSTRACTION AND UNDERLYING FORMS

Establishing underlying forms for the operation of phonological rules is not always as simple as it has been in the examples already given. The choice of underlying voiced phonemes for German in section 3.2 was motivated by the theoretical requirements of economy and simplicity. Yet a certain degree of opacity or abstraction was created in the derivations following rule (5), as the surface form in many words differs from the underlying form posited by the phonologist. An important question in generative phonology is that of how far the posited underlying form can vary from the observed form - or, as Kiparsky (1968) put it, "How abstract is phonology?"

4.1 Abstraction and the clinic

The problem of abstraction is particularly crucial in clinical phonology, where production and comprehension may appear quite at odds with each other, where production may seem inconsistent, where the relation between a patient's production and a supposed "normal" form may be very unclear, and so forth. The following clinical example presents relatively few problems, yet raises important issues in the establishment of underlying representations. The age of the child is not given here.

TABLE XIII

	<u>Word</u>	<u>Adult form</u>	<u>Child's form</u>
1.	cup	/kʌp/	[kʌp]
2.	train	/treɪn/	[tʁeɪn]
3.	socks	/sɒks/	[pɒk]
4.	scissors	/sɪzəz/	[pɪnɜ]
5.	spoon	/spun/	[pʌn]
6.	chocolate	/tʃɒklɪt/	[tʃɒlɪt]
7.	pencil	/pensɪl/	[pɛpɪl]
8.	chair	/tʃɛr/	[tʃɛr]
9.	bed	/bed/	[bɛp]
10.	ship	/ʃɪp/	[pɪp]

(Note: A convention in this table and others puts the "adult" form, which is not transcribed from production, in phonemic notation according to the underlying normal form, and the patient's form, which is transcribed from actual production, in the square brackets of phonetic notation.)

Looking only at the words using /s/ in the adult realization, the child appears to use two rules, stated informally as rules (8) and (9):

$$(8) \quad /s/ \longrightarrow \emptyset / \left\{ \begin{array}{c} \text{---} \# \\ \text{---} \# \end{array} \right. c$$

That is, /s/ is deleted either word-finally or word-initially before another consonant.

$$(9) \quad /s/ \longrightarrow [p] / \text{elsewhere}$$

A more complete rule would note that all of /z, s, ʒ, d/ are collapsed into [p] and account for the [p] of "train". I refrain from presenting such a rule, as it can only operate in conjunction with other ordered rules, yielding a derivation which goes beyond the point of this illustration. Section 5 contains a similar problem and a full rule solution.

4.2 Independence vs. dependence

Rules (8) and (9), while perhaps intuitively satisfying, avoid the issue of abstraction: in what sense is it meaningful to say that the child "has" an underlying /s/? Since the child produces no [s] sounds and since there is no evidence from the data that she attends to semantic distinctions marked only by the presence of /s/, there is no solid basis for assuming an underlying /s/. Using the methodology of phonemic analysis in natural languages, there would be no grounds at all for deriving a /s/ phoneme from this corpus. Rules (8) and (9) are thus very abstract: they rely on an underlying /s/ form which is never uttered by the speaker at the phonetic level. The more concrete solution (i.e. closer to the data of performance) would group together all the child's realizations of [ʃ], whether related to /s/, /z/, /ʒ/, or /d/ in the adult language, as allophones of a single underlying phoneme. For simplicity's sake we can label that phoneme /ʃ/.

Two points of view are thus in contrast. In one view, children's production can be accounted for by mapping adult phonemes (taken as underlying) onto the child's realizations (surface forms) by a series of rules. This approach is implicit in most traditional speech therapy and is found in rules (8) and (9).

Contradicting this view, the child's production can be taken as basic, and an independent set of phonemes and associated rules established without recourse to the adult phonemic system. Hence there is no suggestion that the child "knows" the adult forms at an underlying level but transforms them into non-adult surface forms by a complicated rule process.

These two approaches are represented in Figure I below. Borrowing Luelsdorff's (1975) terms for rule-writing in dialect study, I have stated that the former follows a Dependence Principle (in which the underlying forms posited for the child depend on the adult underlying forms) and the latter an Independence Principle (in which the underlying forms are constructed without regard to the adult forms). Phonemes as analysed under the independence principle are found in Figure I within the vertical lines labelled "contrast", while adult phonemes constructed in the dependence view fall between the horizontal lines labelled "merger".

The role of [p] is shown in Figure I as indeterminate: in the Independence view, it contrasts with /n, ɛ, t/ on the basis of the distinctive features listed to the right of the vertical line under each phoneme. Thus a four-segment phonemic sub-system can be constructed. In the Dependence analysis, [p] merges with the adult phonemes /s, z, ʒ, d/ on the basis of the distinctive features which it shares with

FIGURE 1

merger	contrast	/n/		contrast	merger
		+nas	+son -stri +vcd		
merger	contrast	/s/		contrast	merger
		+cons -son +ant +cor +stri -vcd	-int -nas		
merger	contrast	/z/		contrast	merger
		+cons -son +ant +cor +stri	-int -nas +vcd		
merger	contrast	/v/		contrast	merger
		+cons -son +cor +stri	-ant -int -nas		
merger	contrast	/d/		contrast	merger
		+cons -son +ant +cor +int	-stri -int +vcd		
merger	contrast	/t/		contrast	merger
		+int +stri -vcd	-ant -nas -vcd		
merger	contrast	/č/		contrast	merger
		+int +stri -vcd	-ant -nas -vcd		

these phonemes, listed in the figure to the left of the vertical line under each phoneme. In this view, four segments, which exist in addition to /n,č,t/ are collapsed into the single sound [ŋ].

Since [ɲ] contrasts at the surface level with /n/ and /t/, the child is using the features [nasal], [voiced] and [interrupted] in organizing a sound system. What is problematical is that as the child develops and requires a more complex range of language functions, a phonemic system which does not differentiate among /s, z, d, ʒ/ will not express the full range of English phonological representations. It is entirely possible that the child is aware at some level of a relationship between [ɲ] and the normal adult phonemes: distinctive features clarify the basis on which [ɲ] merges with the adult /s, z, d, ʒ/ and contrasts with /n, t, t/. The child's developmental task, then, will be one of arranging distinctive feature contrasts to differentiate among strident fricatives, to establish a voiced alveolar stop alongside its voiceless counterpart, and to eliminate [ɲ] as a phoneme or phone as a result.

What is the value of presenting both the Dependence and Independence Principles here? The Dependence approach answers a question of immediate relevance to the clinician: what is the relationship between the speaker's production

and normal adult production? A Dependence analysis provides the therapist with a neat way of plotting the correspondences between normal and deviant production. Yet this view is the more abstract, assuming underlying structures which are never realized on the surface by the speaker.

The Independence view may come closer to representing the mental processes by which the child constructs a phonological system. It clarifies the contrasts that exist in the system produced by the child, and enables the analyst to see possible paths for further development based on an observable phonetic system. The Independence Principle is thus addressed to the question: what is the internal logic of the speaker's phonology?

I argue here that both principles are at work in the development of phonology. Part of a speaker's ability might best be described using the Dependence view, while another part might follow a different logic and require an Independent analysis. Data from comprehension tests, which must be interpreted with caution to control for the non-phonological effects of the testing situation, may affect the analyst's interpretation of the patient's productive abilities. Rule derivations based on the Dependence Principle may become so abstract as to conflict with many ideas concerning the psycholinguistic status of phonological rules. In such cases, an Independence analysis may be more accurate. Conversely, an Independence analysis may miss real relationships between a speaker's production and normal adult phonology, settling for a mere taxonomy of observed phonetic forms. The decision of which Principle to use in clinical analysis is not one to be made before the data have been studied, but rather to be made on an individual basis with regard to the data themselves in the light of linguistic and clinical theory.

5 PRACTICE AND THEORY: A CASE STUDY

Having considered distinctive feature analysis and phonological rules, it is time to explore generative phonology in the clinic as a practical skill. Much of the following discussion is not exclusively tied to generative phonology, but represents a general linguistic point of view in considering patients' behaviour and clinical needs.

5.1 Step one: the data

The first step in phonological analysis is to collect and present data in a way that represents the objective facts of performance and is useful to the analysis to be done. The amount and nature of data presented is dictated

by the nature of the collecting session and the objectives of the study. Linguistic theory helps the analyst determine the level of information to be collected and presented, and to separate redundant from crucial phonological information.

The data which follow are from the production of words in isolation by a girl aged six years and two months. The format used below has several important features:

- (i) The entire word as pronounced is transcribed phonetically, so that all environmental details which may influence pronunciation are not lost in later analysis.
- (ii) The Dependence Principle discussed in Section 4 is assumed in presenting data; that is, the underlying representation (UR), not necessarily the phonetic representation, assumed for a normal adult is written to the left of the child's realization. The Dependence view in this case study does not prejudice the Independence Principle: the column headed "UR" could equally be composed of entries based on phonemes derived solely from an Independence analysis.
- (iii) The "Environment" column (E) refines the traditional categories of "initial", "medial" and "final" to enable the therapist to include all relevant environmental factors which condition the alternations observed. Not all "medial" segments, for example, behave in the same way: the variation, however, is seldom random. The specific type of environment (intervocalic, between an obstruent and a vowel, between two sonorants, syllable-initial or -final, etc.) usually make a pattern clear. Word-boundary information in connected speech, syllable stress, and other conditioning factors may be included where appropriate.
- (iv) To the right of the phonetic transcription, each phoneme which plays a part in the speaker's problem areas is listed, whether correctly realized or not. Correct realizations of adult phonemes which are sometimes realized incorrectly do not receive an "Environment" entry. Each line where a "mistake" is made by the patient receives an "Environment" entry and thus reads like a phonological rule: "X:Y /Z". This convention regarding the presence or absence of a notation in the "Environment" column facilitates the analyst in finding a pattern to the conditions which determine "correct" vs. "incorrect" realizations of the underlying phonemes.

- (v) No attempt is made to write phonological rules in the presentation of data. The simplest rules will result only from looking at the sample as a whole.
- (vi) "Blends" are treated as clusters of separate phonemes, rather than as single units. Consonant clusters do not function as single units in normal phonology, and there is no reason to assume that they do so in clinical phonology. Moreover, the phenomena pertaining to these clusters (deletion of one or more members, substitution, etc.) are most concisely described by rules relating to their constituents, rather than by counterfactually treating "blends" as phonemes. Significant generalizations are nearly always lost by treating "blends" separately.

TABLE XIV

<u>Word level</u>			<u>Phoneme level</u>		
<u>Word</u>	<u>UR</u>	<u>SR</u>	<u>UR</u>	<u>SR</u>	<u>E</u>
1. jacket	ʃæ.ɔt	ʃækɔt			
2. snake	sneɪk	neɪk	s	ø	/#—n
			n	n	
3. goose	gus	gut	s	t	/—#
4. eagle	igəl	igəl			
5. rifle	raɪfəl	waɪfəl	r	w	/#—
6. leaf	lif	lif			
7. vase	vaz	vat	z	t	/—#
8. seven	sevn	tevn	s	t	/#—
9. hive	haɪv	haɪv			
10. paper	peɪpər	peɪpər			
11. shop	ʃap	tap	ʃ	t	/#—
12. blob	blab	ab	b	ø	/#—l
			l	ø	/#b—
			b	b	
13. water	water	water			

TABLE XIV
(continued)

<u>Word level</u>			<u>Phoneme level</u>		
<u>Word</u>	<u>UR</u>	<u>SR</u>	<u>UR</u>	<u>SR</u>	<u>E</u>
14. feet	fit	fit			
15. dog	dɔg	gɔg	d	g	/ #—v _g #
16. cushion	kaʃən	kalən	ʃ	l	/V—\$V
17. seesaw	si:ə	tɪtə	s	t	/ #—
			s	t	/V\$—
18. buzzing	baziŋ	batiŋ	b	b	
			z	t	/V—\$V
19. zoo	zu	zu			
20. swimmer	swimər	wimər	s	ʃ	/ #—w
			w	w	
21. ring	riŋ	wiŋ	r	w	/ #—
22. church	čarč	čAč	č	č	/V—C
			r	ʃ	
23. brush	brAš	At	b	ʃ	/ #—r
			r	ʃ	/b—
			š	t	/— #
24. soldier	souljər	touljər	s	t	/ #—
			l	l	
			r	r	
25. spoon	spun	pun	s	ʃ	/ #—p
			p	p	
26. smoke	smouk	mouk	s	ʃ	/ #—m
27. grass	grAs	As	g	ʃ	/ #—r
			r	ʃ	/g—
			s	s	

5.2 Step two: phonetic inventory and inventory of segments tested

The first step in analysing the data is to ascertain just what the child's phonetic capabilities are, and to see if any parts of the adult phonological system have been

missed in testing. The range of sounds tested by the therapist and the sounds actually produced by the speaker are plotted independently as in Figures II and III.

FIGURE II

System tested

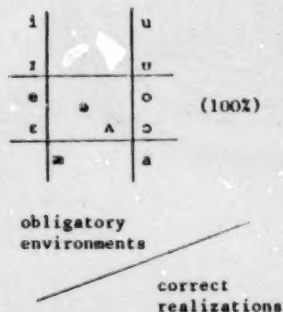
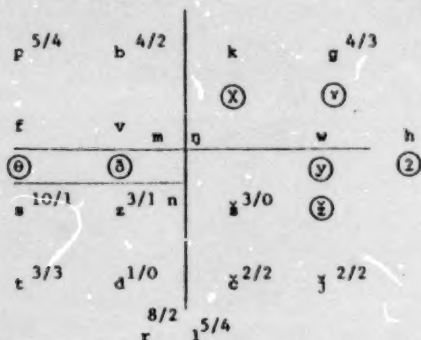
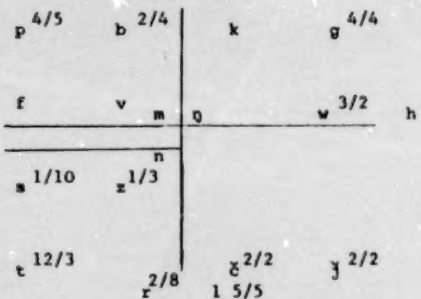


FIGURE III

Phonetic inventory



(Vowels as tested)

realizations
(actual)

obligatory
environments

In the "system tested" chart (Figure II), each adult phoneme in the test words is put in the appropriate place, and problematical phonemes have a numerical value assigned.

The numerator of this fraction is the number of obligatory environments for the phoneme in normal production found in the sample, while the denominator is the number of times this phoneme is correctly realized in obligatory environments.

The "phonetic inventory" (Figure III) uses the same visual format to display the sounds actually produced by the speaker, without regard to whether or not the production was "correct" in a given environment. This inventory is an objective statement of the child's phonetic capabilities as seen from the data. Problematical phonemes appear with a ratio of the number of actual realizations of the specified segment divided by the number of environments in the sample in which this sound is obligatory in normal adult language.

Phonemes which were not tested in Table XIV are shown in Figure II in their appropriate positions with circles around them. The child in this study produced no non-English sounds - a speaker who did would have the segment noted in the chart. Note the distinctive feature classifications implicit in the figure: stops along the outer edges, fricatives in the centre lines, voiced and voiceless pairs in columns, [+coronal] segments along the bottom half, [+anterior] segments on the left-hand side, etc.

5.3 Step three: informal observations

From the data given, the child appears to have near-complete ability to articulate the sounds tested. Of the phonemes tested, only /d/ and /ʒ/ are lacking in production, and /d/ has not been adequately tested, as it occurs only in "dog", for which velar assimilation commonly occurs. The sounds /θ, ð, ʒ, y/ have not been tested, and could have some bearing on generalizations concerning the stop/fricative distinction with coronal consonants. The segments /θ/ and /ð/ may not be realized phonetically in the child's language variety, but their status has not been tested at all in the sample.

Phonological processes which can be taken from the data include: (i) consonant cluster simplification or deletion, (ii) non-adult realization of coronal phonemes in the adult language, and (iii) some minor rules pertaining to phonetic realization. Note that many general processes are not simple in their distribution: /s/ and /z/, for example, while often undergoing "stopping" (i.e. becoming [+interrupted]), are realized correctly in "grass" and "zoo". Though the general tendencies of the child's production are illustrated directly in the data, a deeper analysis using formal rule statements that generalize across the entire sample will yield a useful picture of the processes which the child uses to produce utterances.

5.4 Step four: formal rule statements

Only four rules, with appropriate disjunctions, are needed to account for all the words in the sample. These are as follows:

5.4.1 Consonant cluster deletion

$$(10) \quad \underset{1}{[+cons]} \quad \underset{2}{\begin{bmatrix} +son \\ +cor \\ -nas \end{bmatrix}} \longrightarrow \emptyset \quad / \text{ (context free)}$$

That is, a sequence in which the first segment is [+consonantal] and the second is a non-nasal coronal sonorant (a liquid) is deleted. Rule (10) accounts for all the child's realizations of adult /pr,br,gr,bl,fl/ in the sample.

5.4.2 Coronal phoneme mapping

$$(11) \quad \begin{bmatrix} +cor \\ -son \\ -int \\ <+hi> \end{bmatrix} \longrightarrow \begin{cases} \text{a. } [+vcd] & / \# - v \# \\ \text{b. } [-vcd] & / \# C \begin{bmatrix} +cor \\ +son \end{bmatrix} v - \# \\ \text{c. } \emptyset & / - [-syll] \\ \text{d. } \begin{bmatrix} +son \\ +lat \end{bmatrix} & / v - v \\ \text{e. } \begin{bmatrix} +int \\ -vcd \end{bmatrix} & / \text{ elsewhere} \end{cases}$$

Rule (11) accounts for all the child's realizations of the adult phonemes /z, ʃ, ʒ/ in the following way. Read the rule as follows:

A segment which is a coronal fricative (including /ʃ/, which is [+hi], under special conditions) is realized by the following statements, to be applied in the order given:

- As [z] word-initially in a word containing only a consonant and a vowel (accounts for "zoo").
- As [ʒ] word-finally in a one-syllable word beginning with a consonant cluster as speci-

fied (accounts for "grass).

- c. As zero (i.e. not produced) before a consonant or glide (accounts for "snake", "swimmer", "smoke", and "spoon"; this subsection predicts that /s/ → ∅ in words such as "basket" or "Christmas" as well).
- d. If the segment is also [+hi] (i.e. /ɹ/), then it is realized as [+son, +lat] (i.e. [l]) when surrounded by vowels; assume the syllable boundary is not necessary for the rule (accounts for "cushion").
- e. As a voiceless stop (i.e. [t]) elsewhere (accounts for "goose", "vase", "seven", "shop", "seesaw", "buzzing", "brush", and "soldier"; three adult phonemes in various positions are accounted for in a single rule subsection).

The above rule has the advantage of grouping together a number of similar phoneme changes in a single statement, while taking account of exceptions to the general tendency towards "stopping". Further data are needed to define the exceptions fully, but they may in fact point the way for the therapist to estimate the child's greatest strengths and use these to build a normal adult system. Statements such as rule (10) and rule (11) achieve much greater economy than would be possible in analysing each supposed blend or phoneme separately in "initial/medial/final" position. The shorthand notation of the formal rule statement ultimately saves time and is readily understood by anyone knowing the conventions of generative phonology. These conventions and their theoretical basis thus become a powerful therapist's tool.

5.4.3 /r/ realization

$$(12) \quad \begin{bmatrix} +\text{son} \\ +\text{cor} \\ -\text{nas} \\ -\text{lat} \end{bmatrix} \rightarrow \begin{cases} \text{a. } \begin{bmatrix} +\text{back} \\ -\text{cor} \end{bmatrix} & / \# \text{---} \\ \text{b. } \emptyset & / \text{---C} \end{cases}$$

That is, /r/ becomes [+back, -cons] (i.e. [w]) word-initially, and zero before a consonant. (Accounts for all cases of adult /r/. The two (r) sounds correctly produced in "pepper" and "water" are accounted for by the rule as formulated, since these /r/ sounds are not in the environments listed by the rule.)

5.4.4 /d/ realization

$$(13) \begin{bmatrix} -\text{son} \\ +\text{cor} \\ +\text{int} \\ +\text{vcd} \end{bmatrix} \longrightarrow \begin{bmatrix} +\text{back} \\ -\text{cor} \end{bmatrix} / \# - \vee \begin{bmatrix} +\text{back} \\ +\text{vcd} \end{bmatrix} \#$$

That is, /d/ becomes [+back, -cor] (therefore [g]) in a one-syllable word ending in /g/. (Accounts for "dog".)

5.5 Step five: recommendations

Specific recommendations for therapy cannot be made without further information about the patient, including her physiology, previous therapeutic history, etc. Nevertheless, since a pattern is clear, gaps in the record can be identified and the way of further activity (assessment/therapy) suggested. Specifically:

- (i) The range of consonant clusters tested must be extended to ascertain the full nature of the cluster reduction/deletion process. CCC clusters such as /spl/ and /sp/, as well as non-initial consonant clusters (as in "Christmas" or "basket") would yield information relevant to future therapy.
- (ii) A wider range of coronal phonemes and environments for them should be tested to ascertain the conditions for adult realization of these phonemes by the child. The appearance of "correct" forms in "grass" and "zoo" could be due to lexical exceptions, syllable shape, the nature of the surrounding vowels, or other factors. Knowing the conditions which lead to these realizations may help the therapist to extend the "correct" use of the phonemes by the patient.
- (iii) Manifestations of /r/ should be analysed further, using coronality or syllable position as a possible key to the child's adult realizations of this phoneme.
- (iv) The phoneme /d/ and the untested adult phonemes must be analysed.

The major contribution of generative phonology in speech therapy is to give the therapist tools for making sense out of the production and comprehension of the patient: finding the patterns to seemingly random behaviour, finding the systemic reasons for these patterns, discovering the limitations of the data the therapist is working with at a given time, and relating these observations to the ongoing development of theories of language, mind, social interaction, and therapeutic practice.

Yet linguistic analysis is not therapy. Many non-linguistic factors impinge on the picture presented by a purely linguistic analysis. The linguistically motivated choice in therapy may not be possible in particular therapeutic relationships. The method of analysis presented here should be seen as a minimum: as a means of defining the linguistic system of the patient, with which further information and the results of practice will continuously interact.

Sources of the data not otherwise attributed

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